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ABSTRACT

This paper will adopt Yrjo Engestrom's (1999) expansive learning approach to analyze the situation of a woman, Marieanne, who emigrated to Australia as a child and who later, as a parent, became determined to take an active part in her children's education in order to avoid or ameliorate the repetition of her own negative experiences with mathematics. It will analyze her situation from the perspectives of knowledge interest groups, multi-voicedness, historicity, contradictions, and movement through her zone of proximal development in mathematics education. It will outline her personal development from an intensely shy child whose own education was curtailed for reasons of gender, through her overcoming the barrier of an almost overwhelming lack of confidence as an adult returning to study, to her ultimate success as a learner in her own right as well as a proud role-model for her children and their friends. At no point were Marieanne (or the women or their families in the course in this study) considered as "problems." Rather, the intention was simply to provide "a second chance" to women from a diverse range of circumstances. Engestrom's approach will enable the interrogation of a broad range of possible factors which have contributed to the situation of Marieanne and people like her. (Contains 16 references.) (Author/MM)

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An Expansive Learning Approach to Mathematics Education for Parents: An Australian Case Study

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An Expansive Learning Approach to Mathematics Education for Parents: An Australian Case Study

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Abstract

This paper will adopt Yrjö Engeström's (1999) expansive learning approach to analyse the situation of a woman, Marieanne, who emigrated to Australia as a child and who later, as a parent, became determined to take an active part in her children's education in order to avoid or ameliorate the repetition of her own negative experiences with mathematics. It will analyse her situation from the perspectives of knowledge interest groups, multi-voicedness, historicity, contradictions, and movement through her zone of proximal development in mathematics education. It will outline her personal development from an intensely shy child whose own education was curtailed for reasons of gender, through her overcoming the barrier of an almost overwhelming lack of confidence as an adult returning to study, to her ultimate success as a learner in her own right as well as a proud role-model for her children and their friends. At no point were Marieanne or the women and their families in the course under consideration in this study considered as 'problems'. Rather, the intention was simply to provide 'a second chance' to women from a diverse range of circumstances. Engeström's approach will enable the interrogation of a broad range of possible factors which have contributed to the situation of Marieanne and people like her.

Introduction

The decision by women to return to study mathematics is usually made for a complex array of reasons — institutional, sociocultural, and psycho-social considerations need to be taken into account in this deliberative activity (FitzSimons, 1994b), both as precursors and as possible barriers to be overcome. Not all women are parents of school-age children — many are, yet others have mature families and others are not yet parents (and perhaps never will be); but their spheres of influence are likely to include at some time friends and/or relatives who are school-age children. One of the characteristics of women returning to study is that they frequently feel the need to justify this decision with reference to the needs of others'— whether it is to help children at school (now or at some time in the future) or to help the family business, for example.

Engeström's Expansive Learning Framework

The complexity of the tasks of programme design and delivery for adult mathematics education requires a breadth and depth of understanding of a variety of factors impinging upon the teaching-learning situation in order for the educator to be aware of possible unintended consequences as well as those which are intended. It calls for interrogation of interests, not just of the students' — important as these are — but of a range of groups whose activities can affect in some way the actual outcomes. A valuable framework is provided by the work of Yrjö Engeström.

Building on the work of Lev Vygotsky, Engeström generated a structure for a human activity system, and then a model for two or more interacting activity systems, in order to "develop conceptual tools to understand dialogue, multiple perspectives, and networks of interacting activity systems" (Engeström, 1999, p. 3). He elaborated five principles to summarise Activity theory and cross-tabulated these with four questions central to any theory of learning (figure 1). In this context the concept of learner is

taken broadly, to include *all* participants in the dynamic process — not just the students.

Activity System as a Unit of Analysis.

Firstly, within Activity theory, the prime *unit of analysis* is taken to be "a collective, artifact-mediated and object-oriented system" (Engeström, 1999, p. 4), subsuming individual and group goals, and generating actions and operations. In the case of adults returning to study, the systems of interest include primarily: (a) individual students; (b) their teachers; (c) their families, including the young people who enter the sphere of influence of the adult student; and (d) further educational institutions or community settings. In Australia, research carried out by policy-makers and local institutions of further education is largely instrumental (NCVER, 2001), and little concerned with learning from the students and teachers in the system in a cultural reproduction sense. This paper will focus primarily on the activity groups of adult students and their families.

	Activity system as a unit of analysis	**Multi-voicedness**	**Historicity**	**Contradictions**	**Expansive cycles**
Who are learning?					
Why do they learn?					
What do they learn?					
How do they learn					

Figure 1. Expansive learning model (Engeström, 1999, p. 6)

Multi-Voicedness.

Secondly, account needs to be taken of the principle of *multi-voicedness* — that is, the different positions for participants created by the division of labour within the Activity system. In this case account needs to be taken of the multiple views, traditions and interests of students, their families, teachers, curriculum developers, educational managers, employers, and government bodies. Each of these groups is *multi-voiced* — that is, their lived experiences go far beyond these simple categorisations, and may overlap, with expertise of various forms distributed non-hierarchically. In other words, no adult is 'just a student'. Adults have multiple, partially overlapping identities as parents and relations of young children, as children themselves of aging parents, as workers, citizens, members of various community groups, and so forth. Reasons for wanting to learn mathematics could include: (a) self-realisation, (b) democratic empowerment, and (c) workplace promotion. In acquiring knowledge of the discipline of mathematics, together with incidental knowledge of mathematics education and knowledge of education-institutional structures, the bigger picture for students could include the possibility gaining workplace or lifeskills know-how and certification or other recognition of the skills

they possess and wish to further develop. Teachers may be assumed to learn about the backgrounds and possible foregrounds of their students, for example; while governments need to be able to guarantee some form of public accountability for funding spent on adult education. From a pedagogic perspective, there is — or ought to be — dialogue and debate between positions and voices, focused (in this case) on mathematics education. From a social and economic perspective, interests of employers and government authorities may lie in the values of control over (potential) workers as individuals or groups. It is assumed finally that, overall, interests are focused on progress in the local and/or global economic and/or social spheres.

The questions arise: Whose voices are generally heard in adult and vocational education? Whose voices should be heard? I will return to the issue of multi-voicedness below, listening to a personal account by woman returning to study.

Historicity.

Each participant in the teaching-learning process brings a unique history of life experience, work experience, and education experience — in particular, mathematics education experience, whether formal or otherwise. Frequently the mathematics education experience of adult and vocational students has resulted in an absolutist orientation towards mathematics, supported by expectations of a transmission-based pedagogy (FitzSimons, 1994a). In this paper, the focus will be on the classroom participants rather than the broader activity groups such as policy makers — although their historicity is by no means unimportant (FitzSimons, 2000).

One reason is for asking students in a mathematics return-to-study class to write (or draw) their personal history of mathematics learning is to encourage them to reflect on their experiences and beliefs about mathematics teaching and learning — as much as the students feel comfortable about sharing, although for some this can evoke painful memories. A second reason is that the history provides useful information for the teacher. It can give greater insight into the obstacles that students have faced in order to be in their current situation of both needing and taking up the option of further study in mathematics; in addition, mathematics education histories can inform the teacher of strategies which have had negative consequences in the past. Astute observers may be able to discern a range of curricular and pedagogical approaches to mathematics education over time and across national boundaries (e.g., Alatorre, 2001; FitzSimons, 1994b). With hindsight, it would have been a good exercise for me as the teacher to write and share my own personal mathematics learning history, as well as teaching history.

This is the personal history of one particular student, Marieanne:

> *I really don't remember that much about maths in the early days.*
>
> *After emigrating from Holland my first recollections were of being very frightened amongst people I could not understand. I was always very quiet and was too afraid to ask if I did not understand. Looking back I did grasp the basics but when it came to algebra and geometry, I just couldn't see the point in it at all. I left school at 15 as my parents did not see the point in educating a mere girl.*

I now find I enjoy maths and at last feel that the things I learnt as a child in maths I am starting to understand now. The knowledge I had as a child is still there and it is fun to bring it to the surface.

Although this history is short it has much to say about Marieanne, especially after one has worked with her for some time. Not being able to remember much about the early days is not surprising, given that she was so frightened. Marieanne, like so many women returning to study mathematics, is intelligent, and takes a real delight in learning, especially when she confirms her new knowledge, but also when she affirms her previous knowledge. Yet she was disadvantaged by an Australian school system which presented a fragmented and inadequate response to newly arrived immigrants from non-English speaking backgrounds (Wotley, 2001) and which failed to make mathematics appear relevant to many; and by parents who discriminated against her, curtailing her education because of her gender. Even in her country of origin, The Netherlands, mathematics education for girls is still of particular concern, due the family socialisation processes where girls are expected to hold back, to be subservient to others (M. J. H. Kool, personal communication, 16 July, 2001). In the year following this study Marieanne's education was interrupted yet again, by family responsibilities — not an atypical situation for women returning to study. She has missed many classes on account of illness suffered by her children and by her aging close relatives. While her husband is supportive of her study, he is not in a position to assist with family responsibilities during class time.

Contradictions.

In Australia, contradictions abound in the discrepancies between policy and practice in adult education: for example in the rhetoric of lifelong learning vs. the neoliberal practice of 'User pays' which has acted as a deterrent to many, especially those who fall between the cracks of a technologised welfare system (Butler, 1998). Being technically unable to register for welfare payments, in relative poverty but (perhaps) having a spouse in work, many potential adult learners are without an income high enough to cover the fees which have crept into the system over the last decade. Another example lies in the exhortations of politicians to raise numeracy standards in the face of chronic lack of discipline-based professional development for tutors and literacy teachers teaching numeracy (especially those without recognised entry-level qualifications in mathematics and mathematics education); or in the tensions between new and old curriculum and pedagogical practices in mathematics education.

Contradictions arise from the discipline of mathematics and its related pedagogical practices. Mathematics is considered a high-status subject, and is widely acknowledged for its gate-keeper role in the distribution of various forms of social, cultural, economic, and symbolic capital (Bourdieu, 1991). Yet, as illustrated in the quotation above, mathematics is often seen as difficult to learn (for some), not important for girls, and not problematic for new immigrants or minority groups lacking facility with the language of instruction.

A Teaching Episode

Adults returning to study in a mathematics class where their voices are heard and respected come to trust their teacher and their peers, and to interact in a way formerly unknown to most, if not all. Mathematics comes to be seen as no longer absolute, but fallible and as constructed by humans to meet their particular situated and

contextualised needs. Nevertheless, the discipline is also founded upon the act of generalisation.

In a class of about 10 women we had begun to talk about place value and the decimal system when I had to leave the room to take a phone call. When I returned the women had been talking about the powers of ten, and had started to make a chart on the board. I took the lead:

What is 10 to the power 3?

1000

and 10 to the power 2?

100

so 10 to the power 1 must be?

10.

Someone said: *I can never remember what 10 to the power 0 is.*

I said: Let's work it out. What is happening down this side?

The powers of ten are going down by one each time.

What is happening on this side?

The noughts keep getting crossed off.

What does that mean, when the noughts keep getting crossed off? What are we really doing?

We are taking a short cut We are dividing by ten.

So what is 10 to the power 0?

(Unanimously) *One!*

OK. What is 10 to the power -1?

Is it -1? No it can't be, because the left hand side is –1, says someone.

Someone else says it must be point one.

I write: 0.1 or 1/10. Everyone seems to be happy with this.

What about 10 to the power -2?

.01.

I write: 0.01.

Why are you writing the nought in front of the decimal?

One reason is to indicate that it is not a whole number, and the other is so that you can get a sense of symmetry between tens and tenths, hundreds and hundredths, and so on. (On reflection I should have asked the group why!)

...

After everyone seemed satisfied that they understood how the powers of ten worked, I started a chart with the powers of two. This was not easy. Everyone knew that 2 to the power 2 was 4. There was a slight murmur that 2 to the power 3 might have been 6, but that was quickly adjusted to 8, as they thought about the meaning of two cubed, and I had blocks on the table to model the cube. Two to the power 1 had to be 2, since we were now dividing by 2, and 2 to the power 0 was one. The same as 10 to the power 0!

Does this mean that anything to the power nought must be one? said someone.

Of course it does, answered someone else, *because if you are dividing by the number again and again you must come down to one.*

Well, what about 2 to the power -1? I asked. Then the fun started.

0.2? 0.02? 0.1? they said, enquiringly looking at my face. I moved to the back of the room telling them that I wanted them to work it out and reach a consensus. For several minutes the discussion went back and forth, with nobody being able to satisfy the rest of the group with their justifications. Eventually Jane said:

I don't know what it is, but I know it isn't any of those.

This set everybody thinking on a new track, as they agreed with her. what could it be? I noticed one woman, Betty, had written '½' on her book, but had settled for 0.2. Jane continued:

It can't be 0.2 because we are no longer dividing by ten. And it can't be 0.1 because that was what we had for the powers of ten. It has to be 'twoths, and twoty-twoths, and two-two-loos, but I don't know how to say it. This caused some merriment!

Now everyone was thinking. Eventually Betty quietly said: *0.5*. She said it again a bit louder, and I asked why she said it. Once she explained that it has to be a half, everyone instantly knew she was right, and we finished the chart with 2^{-2} and 2^{-3}, with no problems at all. I found this episode to be very exciting, and a powerful learning experience for all concerned. It provides an example of working with a group of students in their Zone of Proximal Development (ZPD) (see, e.g., Steffe, 1990).

Marieanne's Journals

Students were encouraged to keep weekly journals to reflect on their learning, the progress they are making, and their feelings about the class. The following are examples of Marieanne's journals; the first relates to the episode above:

18/2/92. *The work today has really made me think. It is not what it at first seems with numbers and powers into the negative. I took for granted that the power numbers would be the same as* 10^3 *e.g.* $10^3 = 100$, 2^2 *would be 4, then* 2^{-2} *would be .4, instead it is 1/4 or .25. Once this was realised I could then do the other numbers.*

12/5/92 *I love doing fractions. I feel very confident with them. I am still not sure about the calculator. The process does not seem to stick in my mind.*

19/5/92 *I was frightened of starting negative numbers. Using the red and the black squares I feel I am understanding them better. Homework did not take long as I used the squares to do the additions. I feel fairly confident of addition of negative numbers.*

26/5/92 *What a blow! I feel completely lost, so much for my new confidence. I could not grasp negative numbers today - or rather subtracting negative numbers. For once I felt better using a calculator.*

Hooray I have sat and worked through the sheet. Although I have most of the answers wrong, by going over them with the calculator I am starting to grasp what is happening. I shall try to keep practising and see if it works. I am also at last starting to understand what the number line is for! I actually used it to work out some of the answers or rather corrections together with the calculator. I worked through the sheet again and this time got only 6 wrong. I feel better about it.

These journal entries reflect several things about the class and about Marieanne. Discussion is clearly an important aspect of all classes, and the journals capture some of an ongoing dialogue between the group. They also make reference to the use of multiple representations, such as algebra blocks and the number line, in the study of negative numbers, as well as the integral use of calculators, which provide yet another representation. The journals reflect the nexus between cognition and affect (Schlöglmann, 2001). They show Marieanne's positive attitude towards learning, and her persistence in overcoming initial setbacks. She is able to express her uncertainty without shame or fear of reprisal. These journals are in strong contrast to her learning experiences as a child, in what is being learned and how.

During the first few weeks of class Marieanne completed the Preferred and the Perceived forms of *Constructivist Learning Environment Survey* (Taylor & Fraser, 1991). Three of the four scales were: *Autonomy* (the extent to which students control their learning and think independently), *Prior Knowledge* (the extent to which students' knowledge and experiences are meaningfully integrated into their learning activities), and *Negotiation* (the extent to which students socially interact for the purpose of negotiating meaning and building consensus). Marieanne's perceptions were very close to her preferences in Negotiation and Prior Knowledge, but in Autonomy her perception exceeded her preference. Typical statements in the Autonomy category were: "I decide how much time I spend an activity" and "I do investigations in my own way." Marieanne is not yet fully confident about her own autonomy as a learner, but appeared otherwise fairly supportive of this non-traditional classroom.

Aspects of Activity Theory in Practice

This section will illustrate, through the voice of Marieanne, how Engeström's concept of expansive learning can support mathematics educators in their quest for a more holistic understanding of how the various activity systems of their adult

students, together with their multi-voicedness, historicity and contradictions, can inform the teaching-learning process (see figure 1).

Marieanne, as with all adults returning to study as well as their teachers, is positioned in many non-mutually exclusive roles — as a participant in class, a wife, mother, daughter, paid worker, concerned citizen, and so forth. In acquiring knowledge of the discipline of mathematics, together with incidental knowledge of mathematics education and knowledge of education-institutional structures, the bigger picture for students such as Marieanne could include the possibility gaining workplace or lifeskills know-how and certification. It may also include interacting with young people (often their children) who need support in their own mathematics education. The following is compiled from notes taken in an interview with Marieanne in her own home.

Before I enrolled in the computer class and the maths class I felt depressed. I was working part-time, but looking for something more. All the kids were at school, and I wanted to do something for myself. I was scared of not being able to help them in computers and maths.

When I started back at work I was terrified at first. On the first day I panicked, felt ill. My husband literally pushed me out the door. I built up my confidence after being back at work, but I needed to build up some more confidence through study. You lose your confidence really quickly, when you are not working.

On my first day at the Centre for Women's Education I nearly turned back. My parents were no help. They said: "What do you want to do maths for?" Only my husband and kids gave me support. As I came in, I was talking to myself: "What's the worst they can do? Make me look stupid? Ask me to leave if I was not up to the standard?" I came in because I could not forgive myself for not trying, and would forever wonder if I could do it.

I have kept on coming over the last three years because I feel accepted. My input helps me to understand. I am not made to feel foolish or put down. There are lots of ways of explaining things. I feel comfortable asking questions now-you get more out of it if you do. It took about a year to have the courage to ask, I felt shy. At first I used to ask my husband - now I show him what I do. He boosts me up. Being with much the same group over the three years helps - you get to know each other, and trust is built up.

Personally I have gained confidence from coming to class. The main benefit has been in helping my children. It gives me a great deal of pleasure. We get out the whiteboards and everyone gets excited. Michael (7 years) learned the 11 times tables in grade 2 "the easy way." We started with 2 (digit) numbers, then 3, and so on up to the millions. I used to say: "I wonder what if ..." It felt good to let them think for themselves. We also used a calculator to check.

It was good to see Catherine actually understand fractions. She felt a real glow of pride. She was one of the few in her class who actually understood them, and went out to the board to demonstrate. She was glowing when she came home. I used to trace round plates for circle shapes, and we'd cut out 1/2, 1/4, 1/8. Also

we would fold computer paper sheets. I would start with one child, and all the others would come round to listen and watch. We all enjoy doing it. I set work for the children, and tell them to show all their working out, as this helps their thinking. Sometimes the work is still on the boards when my husband Ken comes home, and he is most impressed.

I started to help the neighbour's children, but Catherine was upset, and asked me not to tell anyone else. She enjoyed having the advantage. She said that I was the only Mum who knew fractions-I can't understand why that is. Knowing that there are many ways of explaining things is useful. Also it's good for girls to have a role model. In any case, Ken isn't home until 8, and then it's too late to help them anyway.

I enjoy maths now, but it was a chore at school. I enjoy finding out new things, exploring, and feeling satisfaction when I understand something that I never knew before. Now it's clicking, dropping into place. At school I was frightened, I would groan, and was fearful when we had maths, because of not understanding. I didn't want my kids to feel that way. Maths was closed for me before, but now it's opened up; there are different paths. I wonder how much I would have learned if I had stayed on at school. Now I will attempt to answer new questions.

Discussion.

Marieanne's interview began by illustrating her multi-voicedness — wanting to do something for herself and also, as a parent, to do something for her children. In fact, many women students returning to study mathematics feel the need to justify their decision in terms of meeting the needs of others — for example, helping with the family business. The second paragraph underlines the contradictions between going to work as a means of building up confidence yet having to be pushed to go on the first day because confidence was so lacking. The same could be said for returning to study mathematics. For many, taking the first step back to study requires an enormous amount of courage — to confront the institution of mathematics and even the institution of education that somehow failed them (taken in both senses of the word 'fail') in the first place. A further contradiction lies in the mixed messages from close family members about her decision to return to study mathematics — clearly her parents' values had not shifted over the years. Close friends are also often sources of conflicting advice. Marieanne, however, chose to place her own values — including 'having a go' or proving herself — above those of her parents, challenging her historicity.

The learning environment provided support for Marieanne to overcome her lack of confidence and to feel accepted as a member of a learning community. It also provided a pedagogical model of an enquiry-based approach, valuing a range of strategies, rather than the authoritarian transmission model experienced by the great majority of adults. In addition, having a mother as a role model of a person who has taken up the challenge of learning mathematics as well as one who models new forms of mathematical thinking cannot but affect her children — and even the neighbourhood children.

Expansive Learning

Engeström's fifth principle proclaims the possibility of *expansive cycles* — "transformations in activity systems" (p. 5). In these relatively long cycles of qualitative transformations, questioning and deviation from established norms sometimes escalates into a deliberate collective change effort. According to Engeström (1999, p. 5) "a full cycle of expansive transformation may be understood as a collaborative journey through the *zone of proximal development* of the activity."

Marieanne's interview also underlined the nexus between cognition and affect. Not only was her self-concept strengthened (she confided that it had helped her during a period of subsequent harassment in the workplace), she was also pleased to be able to constructively assist her children, so that they too have gained in self-confidence in mathematics. One of the goals of our mathematics classes for adults was to present alternative pedagogies to those which alienated and failed many. Classes also helped to inform adult students of the techniques being widely used in modern-day mathematics classrooms. The strategies Marieanne used with her children were based on those used in our mathematics classes. Yet Marieanne, as a mother, knew exactly the most appropriate way of working with her children and celebrating their learning with their father.

This paper has focused primarily upon Engeström's five principles summarising Activity Theory: the systems of analysis, multivoicedness, historicity, contradictions, and expansive learning of adult students enrolled in mathematics classes — albeit at a general level. Given time and space it is possible to expand upon these to interrogate the four central learning-theory questions outlined by Engeström in Figure 1.

There are many opportunities for teachers of these adults to be engaged in expansive learning, both with respect to their students and to their educational institutions, local and national, if not global (see, e.g., Coben, O'Donoghue, & FitzSimons (Eds.), 2000; FitzSimons, O'Donoghue & Coben (Eds.), 2001). In FitzSimons (2000) I address from theoretical and practical perspectives the issues associated with working in different communities of practice that constitute adult and vocational teaching arenas where local sites of teaching and learning are uniquely constituted.

The discourse of *lifelong learning* has been widely adopted by the governments of many nations and by supranational bodies (e.g., Delors, 1996; OECD, 1996). How might alternative, more positive, public perceptions of mathematics and mathematics education be generated and enhanced to encourage the uptake of lifelong education in ways that benefit *all* stakeholders — from policy makers down to the very young in society? More broadly, how might it be possible to involve some or all of the Activity groups listed above in a collective change effort to serve their mutual needs in relation to lifelong learning in mathematics education? In order to benefit all stakeholders, I believe that an expansive cycle, as described by Engeström, is a necessary component. That is, there needs to be open, respectful dialogue between all Activity groups. This interactive symposium at AERA is but one small step.

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